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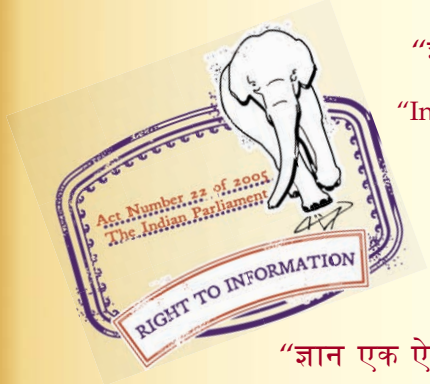

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"Knowledge is such a treasure which cannot be stolen"

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(Reaffirmed 2003)

Indian Standard

HIGH LEVEL DATA LINK CONTROL PROCEDURES

PART 3 CONSOLIDATION OF CLASSES OF PROCEDURES

[ISO Title : Information Processing Systems—Data Communication—High-Level Data Link Control Procedures—Consolidation of Classes of Procedures]

Computers, Business Machines and Calculators Sectional Committee, LTDC 24; Data Communication Subcommittee, LTDC 24:4 [Ref : Doc : LTDC 24 (1062)]

National Foreword

This Indian Standard (Part 3) which is identical with ISO 7809 - 1984 'Information processing systems—Data communications—High level data link control procedures—Consolidation of classes of procedures', issued by the International Organization for Standardization (ISO), was adopted by the Indian Standards Institution on the recommendation of the Computers, Business Machines and Calculators Sectional Committee and approved by the Electronics and Telecommunication Division Council.

Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.

Cross References

International Standard	*Corresponding Indian Standard*
ISO 3309-1984 Information processing systems—Data communication—High-level data link control procedures—Frame structure	IS : 11418 (Part 1)-1986 High level data link control procedures : Part 1 Frame structure (Identical)
ISO 4335-1984 Data communication—High-level data link control procedures—consolidation of elements of procedures	IS : 11418 (Part 2)-1986 High level data link control procedures : Part 2 Consolidation of elements of procedures (Identical)

Adopted 15 January 1986

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0 Introduction

High-level data link control (HDLC) classes of procedures describe methods of data link operation which permit synchronous, code-transparent data transmission between data stations in a variety of logical and physical configurations. The classes are defined in a consistent manner within the framework of an overall HDLC architecture. One of the purposes of this International Standard is to maintain maximum compatibility between the basic types of procedures, unbalanced and balanced, as this is particularly desirable for data stations with configurable capability, which may have the characteristics of a primary, secondary, or combined station, as required for a specific connection.

This International Standard defines three fundamental classes of procedures (two unbalanced and one balanced). The unbalanced classes apply to both point-to-point and multipoint configurations (as illustrated in figure 1) over either dedicated or switched data transmission facilities. A characteristic of the unbalanced classes is the existence of a single primary station at one end of the data link plus one or more secondary stations at the other end(s) of the data link. The primary station is alone responsible for data link management, hence the designation "unbalanced" classes of procedures.

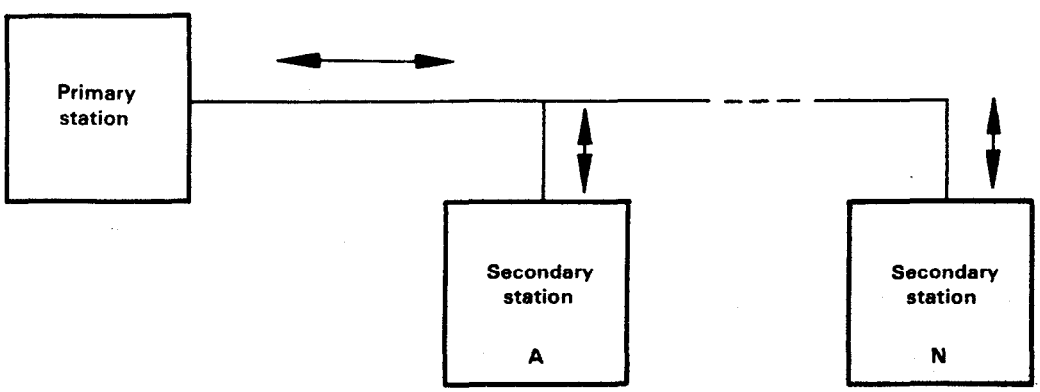

Figure 1 — Unbalanced data link configuration

The balanced class applies to point-to-point configurations (as illustrated in figure 2) over either dedicated or switched data transmission facilities. A characteristic of the balanced class is the existence of two data stations, called combined stations, on a logical data link, that may share equally in the responsibility for data link management, hence the designation "balanced" class of procedures.

For each class of procedures, a method of operation is specified in terms of the capabilities of the basic repertoire of commands and responses that are found in that class. A variety of optional functions are also listed. Procedural descriptions for the use of the optional functions are being considered for inclusion in this International Standard at a later date.

It is recognized that it is possible to construct symmetrical configurations for operation on a single data circuit from the unbalanced classes of procedures which are defined in this International Standard. For example, the combination of two unbalanced procedures (with I frame flow as commands only) in opposite directions would create a symmetrical point-to-point configuration (as illustrated in figure 3).

1 Scope and field of application

This International Standard describes the HDLC unbalanced classes of procedures and the HDLC balanced class of procedures for synchronous data transmission.

Balanced operation is intended for use in circumstances which require equal control at either end of the data link. Operational requirements are covered in accordance with the overall HDLC architecture. The procedures use the HDLC frame structure defined in ISO 3309[1)] and the HDLC elements of procedures described in ISO 4335[2)].

For the unbalanced classes, the data link consists of a primary station plus one or more secondary stations and operates in either the normal response mode or the asynchronous response mode in a point-to-point or multipoint configuration. For the balanced class, the data link consists of two combined stations and operates in the asynchronous balanced mode in a point-to-point configuration. In each class, a basic repertoire of commands and responses is defined, but the capability of the data link may be modified by the use of optional functions.

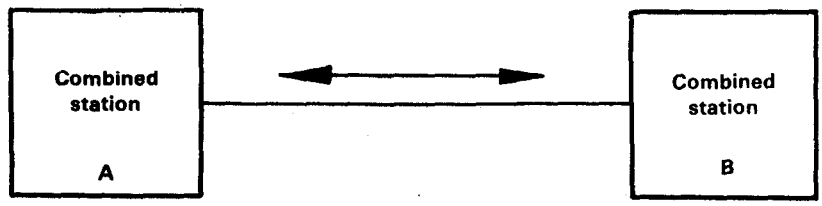

Figure 2 — Balanced data link configuration

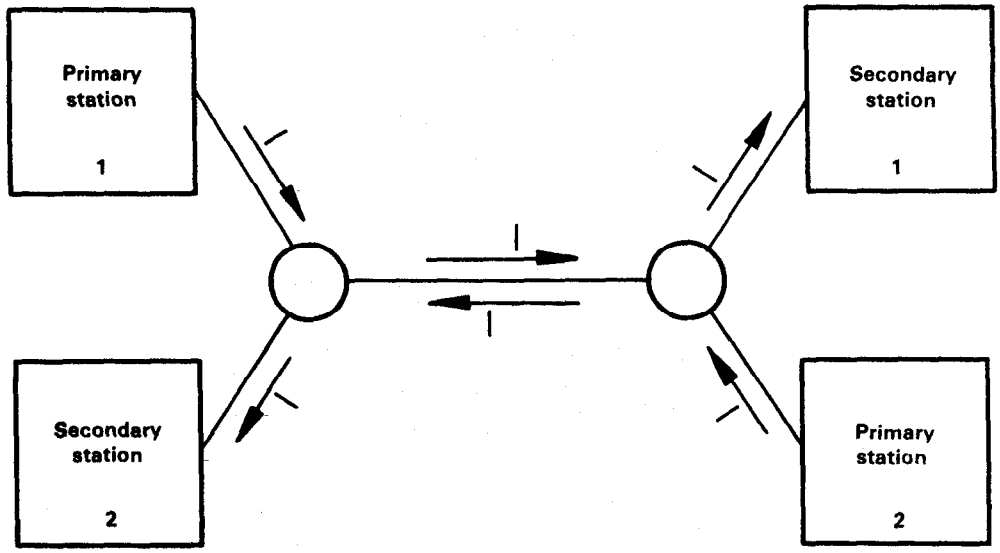

Figure 3 — Symmetrical data link configuration

1) ISO 3309, *Data communication — High-level data link control procedures — Frame structure.*

2) ISO 4335, *Data communication — High-level data link control procedures — Consolidation of elements of procedures.*

2 General description

2.1 Principles

2.1.1 Types of data station

2.1.1.1 Two types of data station are defined for the unbalanced classes of procedures (see figure 4):

a) primary station, which sends commands, receives responses and is ultimately responsible for data link layer error recovery;

b) secondary stations, which receive commands, send responses and may initiate data link layer error recovery.

2.1.1.2 One type of data station is defined for the balanced class of procedures (see figure 4), i.e. combined stations, which send both commands and responses, receive both commands and responses, and are responsible for data link layer error recovery.

2.1.2 Configurations

For the unbalanced classes of procedures, a single primary station plus one or more secondary station(s) shall be connected together over various types of transmission facilities to build point-to-point or multipoint, half-duplex or duplex, switched or non-switched configurations.

For the balanced class of procedures, two combined stations shall be connected together over various types of transmission facilities to build point-to-point, half-duplex or duplex, switched or non-switched configurations.

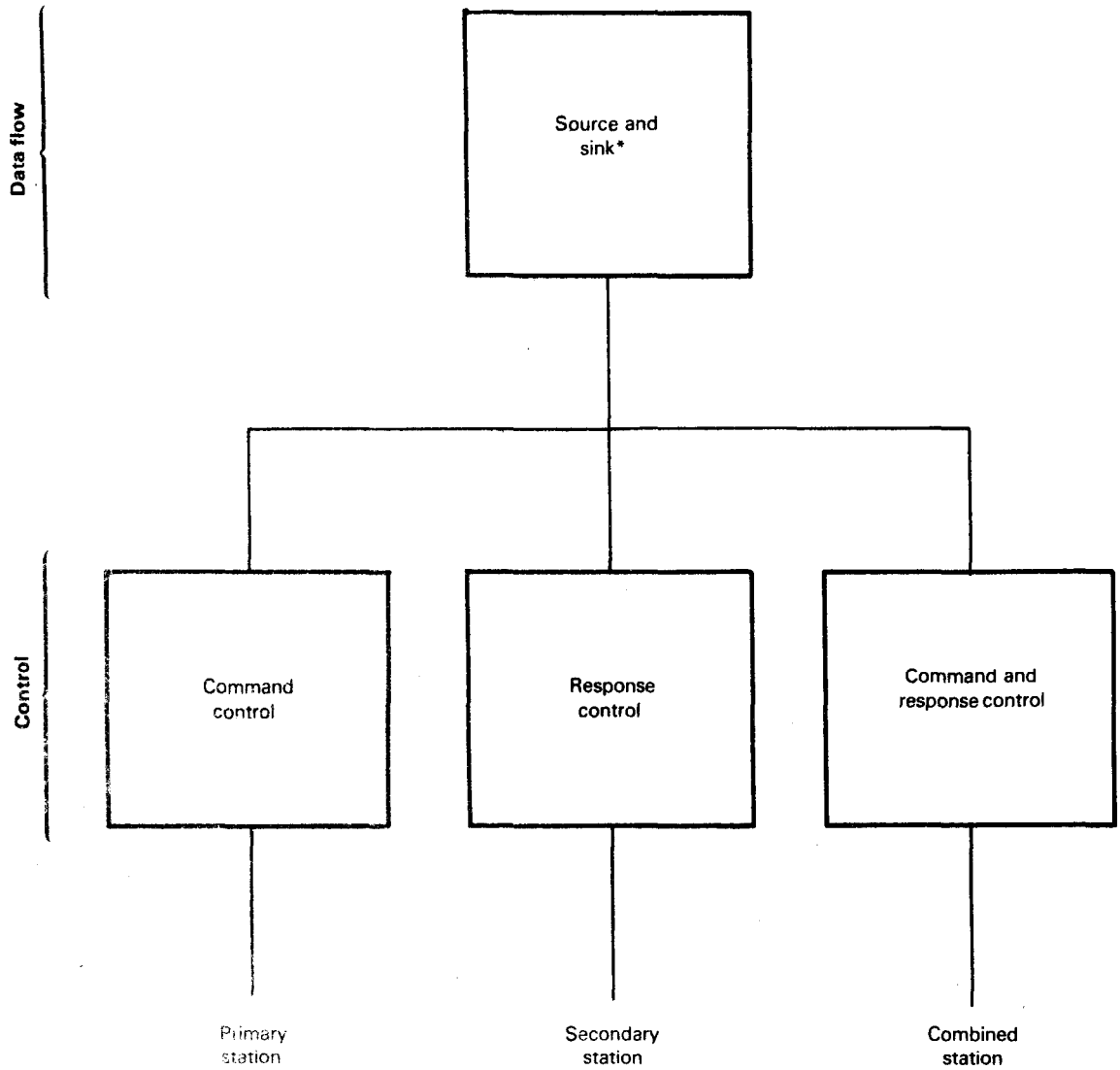

Figure 4 — HDLC stations — Building blocks

* For send-only I frame stations or receive-only I frame stations, remove source or sink capability, as appropriate.

2.1.3 Operational modes

In an unbalanced class, any coupling of a primary station with secondary station(s) shall be operated in either the normal response mode (NRM) or the asynchronous response mode (ARM), two-way alternate or two-way simultaneous, in accordance with the capability of the configuration being employed.

In the balanced class, two combined stations shall be operated in the asynchronous balanced mode (ABM), two-way alternate or two-way simultaneous, in accordance with the capability of the configuration being employed.

2.1.4 Addressing scheme

In all classes (unbalanced and balanced), commands shall always be sent containing a destination data station address, and responses shall always be sent containing the assigned transmitting data station address.

2.1.5 Send and receive state variables

For each primary-to-secondary or combined-to-combined pairing, a separate pair of send and receive state variables shall be used for each direction of transmission of information (I) frames. Upon receipt and acceptance of a mode setting command, both the send and receive state variables of the receiving station shall be set to zero. Upon receipt and acceptance of an acknowledgment response to a mode setting command, both the send and receive state variables of the originating station shall be set to zero.

2.2 Fundamental classes of procedures

2.2.1 Designations

Three fundamental classes of procedures are defined. They are designated:

UNC — Unbalanced operation Normal response mode Class;

UAC — Unbalanced operation Asynchronous response mode Class;

BAC — Balanced operation Asynchronous balanced mode Class.

In these designations

— the first letter, U or B, indicates unbalanced or balanced operation;

— the second letter, A or N, indicates asynchronous or normal response mode;

— the third letter, C, stands for class.

2.2.2 Basic repertoires

The following basic repertoires utilize single octet addressing, unextended control field format, and a 16-bit FCS.

2.2.2.1 UNC

The basic repertoire of commands and responses for UNC shall be as follows:

Commands	Responses
I	I
RR	RR
RNR	RNR
SNRM	UA
DISC	DM
	FRMR

2.2.2.2 UAC

The basic repertoire of commands and responses for UAC shall be as follows:

Commands	Responses
I	I
RR	RR
RNR	RNR
SARM	UA
DISC	DM
	FRMR

2.2.2.3 BAC

The basic repertoire of commands and responses for BAC shall be as follows:

Commands	Responses
I	I
RR	RR
RNR	RNR
SABM	UA
DISC	DM
	FRMR

2.3 Optional functions

Fourteen optional functions are available (see table 1) to modify the fundamental classes of procedures defined in 2.2. These optional functions are obtained by the additions or deletions of commands and responses to or from the basic repertoires, or by the use of alternate address or control field formats or alternate frame checking sequences (see figure 5). Option 11 is applicable to the balanced class of procedures only.

2.4 Consistency of classes of procedures

The consistency in the three classes of procedures, obtained through the use of the concepts of modes of operation, basic command/response repertoires, and hierarchical structuring, is shown in figure 5. This consistency in repertoire facilitates the inclusion of multiple versions of the classes of procedures in a data station that is configurable.

Table 1 — Optional functions

Option	Functional description	Required change
1	Provides the ability to exchange identification and/or characteristics of data stations	Add command: XID Add response: XID
2	Provides the ability for more timely reporting of I frame sequence errors	Add command: REJ Add response: REJ
3	Provides the ability for more efficient recovery from I frame sequence errors by requesting retransmission of a single frame	Add command: SREJ Add response: SREJ
4	Provides the ability to exchange information fields without impacting the I frame sequence numbers	Add command: UI Add response: UI
5	Provides the ability to initialize a remote data station, and the ability to request initialization	Add command: SIM Add response: RIM
6	Provides the ability to perform unnumbered group and all-station polling as well as unnumbered individual polling	Add command: UP
7	Provides for greater than single octet addressing	Use extended addressing format instead of basic addressing format
8	Limits the procedures to allow I frames to be commands only	Delete response: I
9	Limits the procedures to allow I frames to be responses only	Delete command: I
10	Provides the ability to use extended sequence numbering (modulo 128)	Use extended control field format instead of basic control field format. Use SXXME instead of SXXM
11	Provides the ability to reset the state variables associated with only one direction of information flow (for BAC only)	Add command: RSET
12	Provides the ability to perform a basic data link test	Add command: TEST Add response: TEST
13	Provides the ability to request logical disconnection	Add response: RD
14	Provides for 32-bit frame checking sequence (FCS)	Use the 32-bit FCS instead of the 16-bit FCS

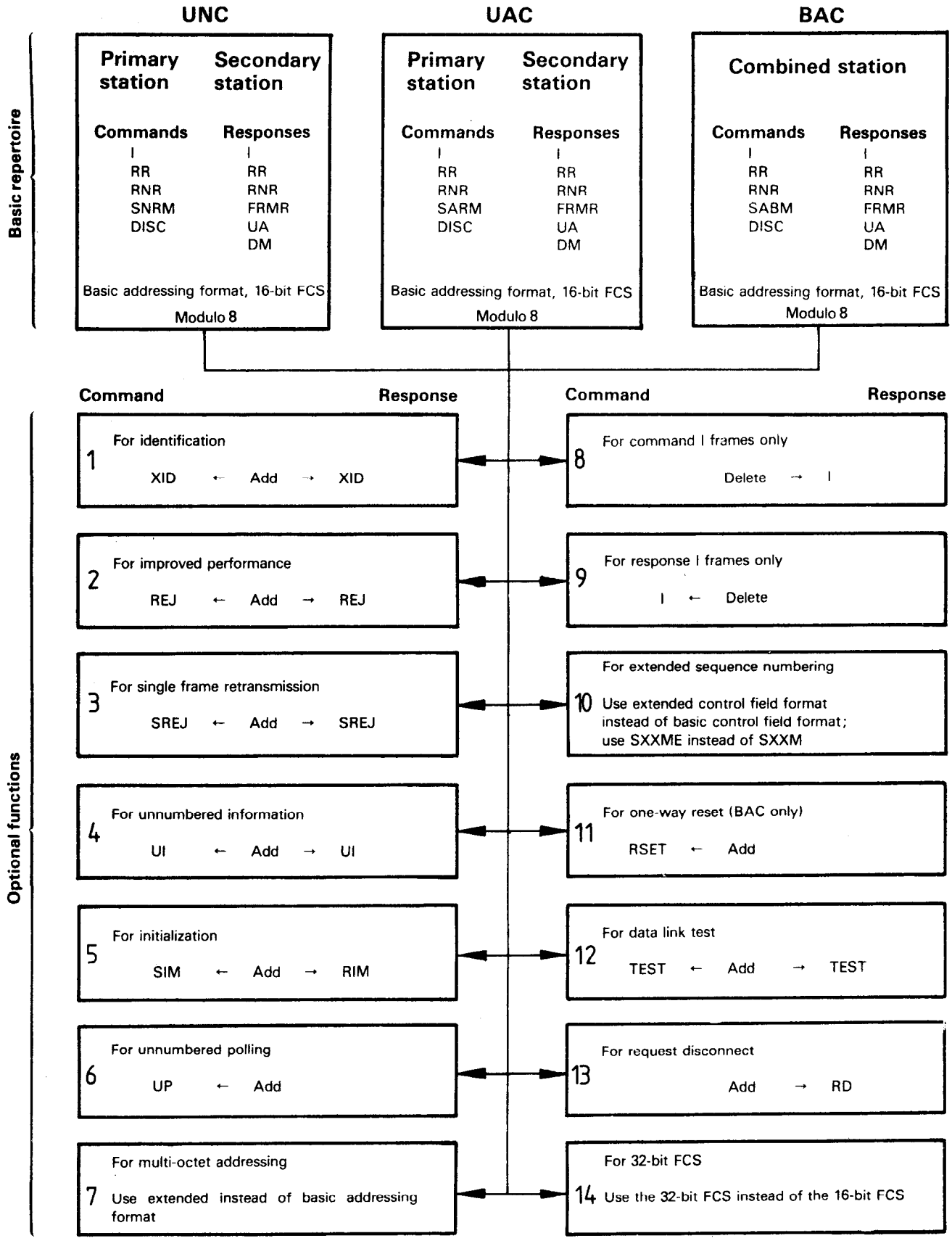

Figure 5 — HDLC classes of procedures

2.5 Conformance to the HDLC classes of procedures

A data station shall be described as conforming to a given class of procedures, with optional functions, if it implements all commands and responses in the basic repertoire for the class of procedures as modified by the selected optional functions, i.e.

a) a primary station shall have the ability to receive all of the responses in the basic repertoire for the unbalanced class of procedures as modified by the selected optional functions;

b) a secondary station shall have the ability to receive all of the commands in the basic repertoire for the unbalanced class of procedures as modified by the selected optional functions;

c) a combined station shall have the ability to receive all of the commands and responses in the basic repertoire for the balanced class of procedures as modified by the selected optional functions.

2.6 Method of indicating classes and optional functions

The classes of procedures and the optional functions shall be indicated by specifying the designation of the class (see 2.2.1) plus the number(s) of the accompanying optional functions (see 2.3).

Example 1: Class UNC 1,2,6,9 indicates the unbalanced operation normal response mode class of procedures with the optional function for identification (XID), improved performance (REJ), unnumbered polling (UP), and one-way data flow from the secondary station(s) to the primary station.

Example 2: Class UAC 1,5,10,13 indicates the unbalanced operation asynchronous response mode class of procedures with the optional functions for identification (XID), initialization (SIM, RIM), extended sequence numbering (modulo 128), and request disconnect (RD).

Example 3: Class BAC 2,8 indicates the balanced operation asynchronous balanced mode class of procedures with the optional functions for improved performance (REJ) and the ability to send I frames as commands only.

3 Unbalanced operation (point-to-point and multipoint)

3.1 General

The following requirements apply to the procedure for unbalanced operation of synchronous data transmission over point-to-point or multipoint data links with two-way alternate or two-way simultaneous data transfer. The procedure uses the HDLC frame structure defined in ISO 3309 and the HDLC elements of procedures described in ISO 4335. It uses the basic command/response repertoire (see figure 5) designated UNC (or UAC). Although only the basic commands and responses are described, there are several optional functions available for enhanced operation. These are listed in 2.3 and shown in figure 5.

NOTE — The HDLC unbalanced classes of procedures operate as illustrated in the examples given in ISO 4335, annex B. (See clause 1.)

3.2 Description of the data link

3.2.1 Configuration (see figure 1)

The unbalanced operation data link configuration shall consist of one primary station and one or more secondary stations interconnected by physical layer transmission facilities.

3.2.2 Physical layer transmission facilities

The physical layer transmission facilities may provide either half-duplex or duplex transmission over switched or non-switched data circuits.

NOTE — In the case of a switched data circuit, the procedures described assume that the switched data circuit has been established.

The data link layer shall not initiate data transmission until an indication of circuit availability is provided by the physical layer. (In some systems providing two-way alternate data exchange on physical layer data circuits using half-duplex transmission, this indication of physical layer circuit availability is indicated by an idle data link channel state.)

3.3 Description of the procedures

3.3.1 General

Unbalanced control procedures shall operate on a data link with one primary station and one or more secondary station(s) in either normal or asynchronous response mode. Only one secondary station at a time shall be put in asynchronous response mode. The primary station shall be ultimately responsible for overall data link error recovery.

Each data station shall check for the correct receipt of the frames it has sent to the remote data station by checking the N(R) of each received I frame or supervisory frame.

3.3.2 Data station characteristics

The primary station shall be responsible for:

a) setting up the data link and disconnecting the data link

b) sending information transfer, supervisory and unnumbered commands; and

c) checking received responses.

Each secondary station shall be responsible for:

a) checking received commands; and

b) sending information transfer, supervisory and unnumbered responses as required by the received commands.

3.4 Detailed definition of the procedures

The procedures for a permanently connected data link or an established switched connection are defined in 3.4.1 to 3.4.6.

The protocol for establishing and disconnecting a switched data circuit is not within the scope of this International Standard. However, the ability to exchange identification and/or characteristics after the switched connection is established is available as an optional function.

3.4.1 Setting up and disconnecting the data link

3.4.1.1 Setting up the data link

The primary station shall initialize the data link with a secondary station by sending a SNRM (or SARM) command and shall start a response time-out function (or equivalent). The addressed secondary station, upon receiving the SNRM (or SARM) command correctly, shall send the UA response at its first opportunity and shall set its send and receive state variables to zero. If the UA response is received correctly, the data link set up to the addressed secondary station is complete, and the primary station shall set its send and receive state variables relative to that secondary station to zero and shall stop the response time-out function (or equivalent). If, upon receipt of the SNRM (or SARM) command, the secondary station determines that it cannot enter the indicated mode, it shall send the DM response. If the DM response is received correctly, the primary station shall stop the response time-out function (or equivalent).

If the SNRM (or SARM) command, UA response or DM response is not received correctly, it shall be ignored. The result will be that the primary station's response time-out function (or equivalent) will run out, and the primary station may resend the SNRM (or SARM) command and restart the response time-out function (or equivalent) (see 3.4.3).

This action may continue until a UA response has been received correctly or until recovery action takes place at a higher level.

3.4.1.2 Disconnecting the data link

The primary station shall disconnect the data link with a secondary station by sending a DISC command and shall start a response time-out function (or equivalent). The addressed secondary station, upon receiving the DISC command correctly, shall send a UA response at its first opportunity and shall enter the normal disconnected mode (NDM), or the asynchronous disconnected mode (ADM), as predefined for that secondary station. If, upon receipt of the DISC command, the addressed secondary station is already in the disconnected mode, it shall send the DM response. The primary station, upon receiving a UA or DM response to a sent DISC command, shall stop the response time-out function (or equivalent).

If the DISC command, UA response or DM response is not received correctly, it shall be ignored. This will result in the expiry of the primary station's response time-out function (or equivalent), and the primary station may resend the DISC command and restart the response time-out function (or equivalent) (see 3.4.3).

This action may continue until either the UA response or a DM response has been received correctly or until recovery action takes place at a higher level.

3.4.1.3 Procedure in a disconnected mode

A secondary station in NDM (or ADM) shall monitor commands, shall react, at the earliest respond opportunity, to a SNRM (or SARM) command as outlined in 3.4.1.1, and shall respond with a DM response to a received DISC command. The secondary station shall respond to other commands received with the P bit set to "1" with a disconnected mode (DM) response with the F bit set to "1". Other commands received with the P bit set to "0" shall be ignored. The DM response shall be used to report the secondary station status asynchronously in ADM.

3.4.2 *Exchange of information (I) frames*

3.4.2.1 Sending I frames

The control field format shall be as defined in ISO 4335 (see clause 1) for an I frame, with N(S) set to the value of the send state variable V(S) and with N(R) set to the value of the receive state variable V(R). Following data link set-up, both V(S) and V(R) shall be set to zero. The maximum length of I frames shall be a system-defined parameter.

If the data station is ready to send an I frame numbered N(S), where N(S) is equal to the last received acknowledgment plus the modulo-1, the data station shall not send the I frame but shall follow the procedures described in 3.4.3.

3.4.2.2 Receiving I frames

After a data station receives correctly an in-sequence I frame that it can accept, it shall increment its receive state variable V(R), and, at its next opportunity to send, take one of the following actions:

a) If information is available for transmission and the remote data station is ready to receive, it shall act as described in 3.4.2.1 and acknowledge the received I frame(s) by setting N(R) in the control field of the next transmitted I frame to the value of V(R).

b) If information is not available for transmission but the data station is ready to receive I frames, the data station shall send an RR frame and acknowledge the received I frame(s) by setting N(R) to the value of V(R).

c) If the data station is not ready to receive further I frames, the data station may send an RNR frame and acknowledge the received I frame(s) by setting the N(R) to the value of V(R).

If the data station is unable to accept the correctly received I frame(s), V(R) shall not be incremented. The data station may send an RNR frame with the N(R) set to the value of V(R).

3.4.2.3 Reception of incorrect frames

If a frame is received with an incorrect FCS, it shall be discarded.

If an I frame is received with a correct FCS but with an incorrect N(S), the receiving data station shall ignore the N(S) field and discard the information field in that frame. This shall continue until the expected I frame is received correctly. The data station shall, however, use the P/F and N(R) indications in the discarded I frames. The data station shall then acknowledge the expected I frame, when received correctly, as described in 3.4.2.2.

The P/F recovery (checkpointing) shall cause retransmission of the I frames received incorrectly, as described in 3.4.4.

3.4.2.4 Data station receiving acknowledgments

A data station receiving an I, RR or RNR frame with a valid N(R) = x shall treat as acknowledged all previously transmitted I frames up to and including the I frame transmitted with N(S) equal to $x - 1$.

3.4.3 Time-out considerations

In order to detect a no-reply or lost-reply condition, each primary station shall provide a response time-out function (or equivalent). Also, in ARM, each secondary station shall provide a command time-out function (or equivalent). In each case, the expiry of the time-out function (or equivalent) shall be used to initiate appropriate error recovery procedures. In NRM, a secondary station shall depend on the primary station to initiate time-out recovery.

The duration of time-out functions (or equivalent) shall be system-dependent and subject to bilateral agreement. To resolve possible contention situations in ARM, the duration of the secondary station's time-out function shall be different from that of the primary station.

3.4.4 P/F bit usage

P/F bit usage in the unbalanced classes of procedures, UNC and UAC, shall be as described in ISO 4335.

3.4.5 Two-way alternate considerations

In the case of normal respond opportunity, two-way alternate, data link operation

a) transmission from the primary station shall not be allowed until either

1) receipt of a frame with the F bit set to "1", or

2) expiry of a no-response time-out function; and

b) transmission from the secondary station shall not be allowed until receipt of a frame with the P bit set to "1".

NOTE — In multipoint configurations of normal respond opportunity, two-way alternate, data link operation over duplex physical facilities, the primary station may transmit frames with the P bit set to "0" to non-polled secondary stations in the above mentioned period.

In the case of normal respond opportunity, two-way alternate, data link operation, a data station shall not accept further frames after a frame with the P/F bit set to "1" was accepted and before it sends a frame with the F/P bit, respectively, set to "1".

In the case of asynchronous respond opportunity, two-way alternate, data link operation, transmission from a data station shall not be allowed until either

a) detection of an idle data link channel state after receipt of a frame or a flag; or

b) the end of an extended period of inactivity (idle data link channel state).

NOTE — In the case of half-duplex data circuit facilities, appropriate accommodation has to be made to control the direction of data transmission. The direction of transmission is controlled by the data link layer, and may be signalled by the physical layer.

If no frames were transmitted from either data station while in ARM and information is waiting for transmission, it is advisable that the data station transmits at first a supervisory frame only in order to avoid long time recovery action, which would occur in the case of I frame contention.

If a data station has transmitted frames and no further frames are pending for transmission, it shall give the right to transmit to the remote data station.

3.4.6 Two-way simultaneous considerations

For each unbalanced class of procedures, two-way simultaneous communication protocols may be used independent of physical data circuit capability (i.e. half-duplex transmission). However, in the case of half-duplex data circuit facilities, appropriate accommodation has to be made to control the direction of data transmission. The direction of transmission is controlled by the data link layer. In addition, in the case of normal respond opportunity, data transmission from the secondary station shall not be allowed until receipt of a frame with the P bit set to "1".

4 Balanced operation (point-to-point)

4.1 General

The following requirements apply to the procedure for balanced operation of synchronous data transmission over point-to-point data links with two-way alternate or two-way simultaneous data transfer. The procedure uses the HDLC frame structure defined in ISO 3309 and the HDLC elements of procedures described in ISO 4335.

It uses the basic command/response repertoire (see figure 5) designated BAC. Although only the basic commands and responses are described, there are several optional functions available for enhanced operation. These are listed in 2.3 and shown in figure 5.

NOTE — The HDLC balanced class of procedures operates as illustrated in the examples given in ISO 4335, annex B. (See clause 1.)

4.2 Description of the data link

4.2.1 Configuration (see figure 2)

The balanced operation data link configuration shall consist of two combined stations interconnected by physical layer transmission facilities.

4.2.2 Physical layer transmission facilities

The physical layer transmission facilities may provide either half-duplex or duplex transmission over switched or non-switched data circuits.

NOTE — In the case of a switched data circuit, the procedures described assume that the switched data circuit has been established.

The data link layer shall not initiate data transmission until an indication of circuit availability is provided by the physical layer. (In some systems providing two-way alternate data exchange on physical layer data circuits using half-duplex transmission, this indication of physical layer circuit availability is indicated by an idle data link channel state.)

4.3 Description of the procedures

4.3.1 General

Balanced control procedures shall operate on a data link where the data station at each end of the data link is a combined station. The procedures shall use the asynchronous balanced mode. Each combined station shall be equally responsible for data link layer error recovery.

Each combined station shall check for the correct receipt of the I frames it has sent to the remote combined station by checking the N(R) of each received I frame or supervisory frame.

4.3.2 Combined station characteristics

Each station shall be a combined station, i.e. it shall be able to set up the data link, disconnect the data link, and both send and receive commands and responses.

4.4 Detailed definition of the procedures

The procedures for a point-to-point data link using a permanently connected or an established switched connection are defined in 4.4.1 to 4.4.6.

The protocol for establishing and disconnecting a switched data circuit is not within the scope of this International Standard. However, the ability to exchange identification and/or characteristics after the switched connection is established is available as an optional function.

4.4.1 Setting up and disconnecting the data link

4.4.1.1 Setting up the data link

Either combined station may take the initiative to initialize the data link. It shall send the SABM command and start a response time-out function (or equivalent). The other combined station, upon receiving the SABM command correctly, shall send a UA response and reset both its send and receive state variables to zero. If the UA response is received correctly, the data link set-up shall be complete, and the initiating combined station shall set both its state variables to zero, stop the response time-out function (or equivalent), and enter the indicated mode. If, upon receipt of the SABM command, a combined station determines that it can not enter the indicated mode, it shall send the DM response. If the DM response is received correctly, the initiating combined station shall stop the response time-out function (or equivalent).

If a SABM command, UA response or DM response is not received correctly, it shall be ignored. The result will be that the response time-out function (or equivalent) will run out in the combined station which originally sent the SABM command and that combined station may resend the SABM command and restart the response time-out function (or equivalent) (see 4.4.3).

This action may continue until a UA response has been received correctly or until recovery action takes place at a higher layer.

4.4.1.2 Disconnecting the data link

Either combined station may take the initiative to disconnect the data link. It shall send the DISC command and start a response time-out function (or equivalent). The other combined station, in an operational mode, upon receiving the DISC command correctly, shall send a UA response and enter the asynchronous disconnected mode (ADM). If, upon receipt of the DISC command, the other combined station is already in the disconnected mode, it shall send the DM response. The initiating combined station, on receiving a UA or DM response to a sent DISC command, shall stop its response time-out function (or equivalent).

If a DISC command, UA response or DM response is not received correctly, it shall be ignored. The result will be that the response time-out function (or equivalent) will run out in the combined station which originally sent the DISC command unless a separate mode setting command is received, in which case the response time-out function (or equivalent) may be stopped. This combined station may resend the DISC command and restart its response time-out function (or equivalent).

This action may continue until a UA or DM response has been received correctly, a DISC command has been received correctly, or until recovery action takes place at a higher layer.

4.4.1.3 Procedure in a disconnected mode

A combined station in ADM shall monitor received commands, shall react to a SABM command as outlined in 4.4.1.1, and shall respond with a DM response to a received DISC command. It shall respond to other commands received with the P bit set to "1" with a disconnected mode (DM) response with the F bit set to "1". Other commands received with the P bit set to "0" shall be ignored. The DM response shall be used to report the combined station status asynchronously in ADM.

4.4.1.4 Simultaneous attempts to set mode (contention)

When a combined station issues a mode setting command and, before receiving an appropriate response, receives a mode setting command from the remote combined station, a contention situation has developed. Contention situations shall be resolved in the following manner.

When the sent and received mode setting commands are the same, each combined station shall send a UA response at the earliest respond opportunity. Each combined station shall either enter the indicated mode immediately or defer entering the indicated mode until receiving a UA response. In the latter case, if the UA response is not received, the combined station may enter the mode when the response time-out function (or equivalent) expires, or the combined station may reissue the mode setting command.

When the mode setting commands are different, each combined station shall enter ADM and issue a DM response at the earliest respond opportunity. In the case of a DISC command contention with a different mode setting command, no further action is required. In the case of contention between SABM and SABME commands, the combined station sending the SABME command shall have priority over the combined station sending the SABM command in re-attempting data link establishment.

4.4.2 Exchange of information (I) frames

4.4.2.1 Sending I frames

The control field format shall be as defined in ISO 4335 (see clause 1) for an I frame, with N(S) set to the value of the send state variable V(S) and with N(R) set to the value of the receive state variable V(R). Following data link set-up, both V(S) and V(R) shall be set to zero. The maximum length of I frames shall be a system-defined parameter.

If the combined station is ready to send an I frame numbered N(S), where N(S) is equal to the last received acknowledgment plus the modulo-1, the combined station shall not send the I frame but shall follow the procedures described in 4.4.3.

The decision whether to send an I frame as a command or as a response, i.e. to use the remote or the local address to indicate a P or an F bit, respectively, shall depend on the need to acknowledge a received P bit set to "1" by transmitting a response with the F bit set to "1".

4.4.2.2 Receiving I frames

After a combined station receives correctly an in-sequence I frame that it can accept [i.e. N(S) equals the value of the receive state variable V(R)], the combined station shall, at its next opportunity to send, take one of the following actions:

a) if information is available for transmission and the remote combined station is ready to receive, it shall act as described in 4.4.2.1 and acknowledge the received I frame(s) by setting N(R) in the control field of the next transmitted I frame to the value of V(R);

b) if information is not available for transmission, but the combined station is ready to receive I frames, the combined station shall send an RR frame and acknowledge the received I frame(s) by setting N(R) to the value of V(R); or

c) if the combined station is not ready to receive further I frames, the combined station may send an RNR frame and acknowledge the received I frame(s) by setting the N(R) to the value of V(R).

If the combined station is unable to accept the correctly received I frame(s), V(R) shall not be incremented. The combined station may send an RNR frame with the N(R) set to the value of V(R).

The I or supervisory frame transmitted will be either a command or a response depending on whether a P bit set to "1" or an F bit set to "1" transmission, respectively, is required. If the transmission of a P bit or F bit set to "1" is not required, the acknowledgment frames may be either commands or responses.

4.4.2.3 Reception of incorrect frames

If a frame is received with an incorrect FCS, it shall be discarded.

If an I frame is received with a correct FCS but with an incorrect N(S), the receiving combined station shall ignore the N(S) field and discard the information field in that frame. This shall continue until the expected I frame is received correctly. The combined station shall, however, use the P/F and N(R) indications in the discarded I frames. The combined station shall then acknowledge the expected I frame, when received correctly, as described in 4.4.2.2.

The P/F recovery (checkpointing) shall cause the retransmission of the I frames received incorrectly, as described in 4.4.4.

4.4.2.4 Combined station receiving acknowledgments

A combined station receiving an I, RR, or RNR frame with a valid N(R) = x shall treat as acknowledged all previously transmitted I frames up to and including the I frame transmitted with N(S) equal to $x - 1$.

4.4.3 Time-out considerations

In order to detect a no-reply or lost-reply condition, each combined station shall provide a response time-out function (or equivalent). The expiry of the time-out function (or equivalent) shall be used to initiate appropriate error recovery procedures.

The duration of time-out functions (or equivalent) shall be system-dependent and subject to bilateral agreement. The duration of the time-out function (or equivalent) in the two combined stations shall be unequal in order to resolve contention situations, especially in two-way alternate operation.

The time-out function (or equivalent) shall be started whenever the combined station has transmitted a frame for which a reply is required. When the expected reply is received, the time-out function (or equivalent) shall be stopped. If, during the interval that the time-out function (or equivalent) is running, other

frames are sent for which acknowledgments are required, the time-out function (or equivalent) may have to be restarted.

If the response time-out function (or equivalent) runs out, a command with the P bit set to "1" may be (re)transmitted, and the response time-out function (or equivalent) restarted.

4.4.4 P/F bit usage

P/F bit usage in the balanced class of procedure, BAC, shall be as described in ISO 4335 (see clause 1).

4.4.5 Two-way alternate considerations

In two-way alternate, data link operation, transmission from a combined station shall not be allowed until either

a) detection of an idle data link channel state after receipt of a frame or a flag; or

b) the end of an extended period of inactivity (idle data link channel state).

NOTE — In the case of half-duplex data circuit facilities, appropriate accommodation has to be made to control the direction of data transmission. The direction of transmission is controlled by the data link layer, and may be signalled by the physical layer.

If no frames were transmitted from either combined station while in ABM and information is waiting for transmission, it is advisable that the combined station transmits at first a supervisory frame only in order to avoid long time recovery action, which would occur in the case of I frame contention.

If a combined station has transmitted frames and no further frames are pending for transmission, it shall give the right to transmit to the remote combined station.

4.4.6 Two-way simultaneous consideration

For the balanced class of procedures, two-way simultaneous communication protocols may be used independent of physical data circuit capability (i.e. half-duplex or duplex transmission). However, in the case of half-duplex data circuit facilities, appropriate accommodation has to be made to control the direction of data transmission. The direction of transmission is controlled by the data link layer.

Annex

Examples of typical HDLC procedural subsets

(This annex does not form part of the standard.)

A.1 Introduction

The HDLC procedures are designed to cover a wide range of applications (for example, two-way alternate [TWA], two-way simultaneous [TWS] data communication between computers, concentrators and terminals) and a wide range of configurations (for example, multipoint or point-to-point, switched or non-switched, half-duplex or duplex).

International Standards dealing with HDLC define a number of necessary characteristics, including frame formats, operational modes, commands, responses and exception recovery techniques. These functions, used in various combinations, provide the full range of capabilities included in HDLC.

The majority of HDLC implementations will not require the full range of capabilities provided by these International Standards. Therefore, this annex describes several typical subsets of the HDLC procedures to provide uniform HDLC implementations intended to meet the majority of applications required in the immediate future. Use of these suggested typical subsets will help to promote interoperability among independent HDLC implementations designed to satisfy similar operational requirements.

Other procedural subsets may be chosen to meet new or additional requirements provided that they conform to the classes defined in this International Standard.

A.2 Selection parameters

In order to define these typical HDLC procedural subsets, the following application parameters have been considered:

- data communication (TWA, TWS); and
- configuration [point-to-point (pt-pt), multipoint (mpt)].

From these parameters, three typical procedural subsets have been selected as examples and are summarized in table 2.

The optional functions 2, 8 and 10 are recapitulated in table 3 (see also table 1).

Table 2 — Typical HDLC procedural subsets

Parameters		Typical HDLC procedural subsets	
Data communication	Configuration	No.	Definition
TWA	mpt/pt-pt[1)]	1	UNC
TWS	mpt/pt-pt[1)]	2	UNC 2
	pt-pt	3	BAC 2,8[2)]

1) Point-to-point may be viewed as a specific multipoint configuration.

2) BAC 2,8,10 is recommended in some cases (see 4.3.2).

Table 3 — Optional functions 2, 8 and 10

Option	Functional description	Command	Response	Comment
2	Provides the ability for more timely reporting of I frame sequence errors	Add REJ	Add REJ	
8	Limits the procedures to allow I frames to be commands only		Delete I	
10	Provides the ability to use extended sequence numbering (modulo 128)	Add SABME Delete SABM		Uses extended control field format instead of basic control field format

A.3 Common features

The following common features have been established for all the procedural subsets described in clause A.4:

- data integrity and recovery is assured by P/F checkpointing;
- time-outs are used in conjunction with the P/F mechanism; and
- each subset may be used with either half-duplex or duplex transmission.

A.4 Typical procedural subsets

A.4.1 Subset 1: TWA, multipoint or point-to-point, UNC (no options)

Commands	Responses
I	I
RR	RR
RNR	RNR
SNRM	UA
DISC	DM
	FRMR

This procedural subset uses the P/F bit for polling of information and status, for last frame indication and for checkpointing. The subset is suitable for two-way alternate operation on point-to-point or multipoint configurations. In two-way alternate, multipoint configurations operating over duplex physical facilities, the primary station may at any time transmit frames with the P bit set to "0" to non-polled secondary stations. Primary and secondary stations shall be able to receive all listed responses and commands from the remote data station.

A.4.2 Subset 2: TWS, multipoint or point-to-point, UNC 2

Commands	Responses
I	I
RR	RR
RNR	RNR
REJ	REJ
SNRM	UA
DISC	DM
	FRMR

This procedural subset uses the P/F bit for polling of information and status, for last frame indication and for checkpointing. The REJ frame is used by a data station to request retransmission of I frames. The subset is suitable for multipoint or point-to-point configurations where the primary and secondary stations are both capable of two-way simultaneous communication. Some point-to-point data links may be considered as specific multipoint data links. Primary and secondary stations shall be able to receive all listed responses and commands from the remote data station.

A.4.3 Subset 3

A.4.3.1 Non-extended sequence numbering: TWS, point-to-point, BAC 2,8

Commands	Responses
I	
RR	RR
RNR	RNR
REJ	REJ
SABM	UA
DISC	DM
	FRMR

This procedural subset uses the P/F bit for polling of status, and for checkpointing. The REJ frame is used by a data station to request retransmission of I frames. The subset is suitable for two-way simultaneous communication on point-to-point data links when symmetrical control of the data link is desirable. Both combined stations shall be able to receive all listed commands and responses.

NOTE – X.25 LAPB is compatible with this procedure.

A.4.3.2 Extend sequence numbering: TWS, point-to-point, BAC 2,8,10

Commands	Responses
I	
RR	RR
RNR	RNR
REJ	REJ
SABME	UA
DISC	DM
	FRMR

This procedural subset is applicable in the same conditions as the non-extended one, when higher performance is needed on data links with specific characteristics such as long round trip delays and short information field lengths.

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